1. **Chemical measurements part 1 – Chemical changes and conservation of mass**

1. A piece of magnesium was heated in a crucible.



a) Write a balance equation to show how the magnesium reacts with oxygen. (2)

 ***2Mg(s) +O2(g)  2MgO(s) (1 mark for formulae and 1 mark for balancing)***

b) The mass of the crucible at the start of the reaction was 0.34g, but 0.56g at the end. Explain why the

 mass increased. (2)

 ***Oxygen from the air / atmosphere (1) has bonded / reacted with the magnesium (1)***

c) The student heated the crucible at the end of the reaction. What could the student do to make sure

 the reaction is complete? (2)

 ***Reweigh the crucible (1) if the two masses are the same, the reaction is complete (1)***

d) Another student heated magnesium carbonate in a similar crucible, with the lid off.

 The reaction is shown below:

MgCO3 (s)  MgO (s) + CO2 (g)

 Use the reaction to explain whether the mass would increase or decrease. Explain your answer. (3)

  ***The mass will decrease (1) carbon dioxide / as gas (is produced or given off (1) which can escape (1)***

1. **Chemical measurements part 2 – Relative formula mass**
2. Calculate the relative formula mass of Na2CO3. (1)

***106 (1)***

1. Calculate the relative atomic mass of Iron (with 5.8% 54Fe, 91.8% 56Fe, 2.1% 57Fe and 0.3% 59Fe). (2)

***Ar of Fe = (5.8 × 54) + (91.8 × 56) + (2.1 × 57) + (0.3 × 58)/100 = 5591.1/100 = 55.9***

1. **Calculations part 1 – Moles/Quantities/Balancing and Limiting factors (HT)**

1. How many moles of sulfur atoms are there in:

 a) 9.8 grams of sulfur? (1)

***0.3 moles (1)***

b) 16 tonnes of sulfur? (where 1 tonne = 1000kg) (1)

 ***500000 moles (1)***

 2. What is the mass of:

a) 0.04 moles of hydrogen H2? (1)

 ***0.04 x 2 (1x2) = 0.08g (1)***

b) 0.6 moles of sodium nitrate (NaNO3)? (2)

 ***23 + 14 + (16x3) = 85 (1)***

 ***0.6x 85 = 51g (1)***

3. When calcium reacts with water it forms a solution of calcium hydroxide Ca(OH)2 and hydrogen gas.

 a) Write a balanced symbol equation, including the state symbols to show this equation. (3)

 ***Ca(s) + 2H2O(l) → Ca(OH)2(aq) + H2(g)***

 ***1 mark for symbols, 1 mark for balancing and 1 mark for state symbols***

1. Calculate how much calcium must be added to an excess of water to produce 3.7g of calcium hydroxide (2)

***2.0g (2)***

4. What mass of sodium chloride is produced when 5.3g of sodium carbonate reacts with excess dilute

 hydrochloric acid? (3)

Na2CO3 + 2HCl  2NaCl + H20 + CO2

 ***Mr of sodium carbonate = (23x2) +12+(16x3) = 106 [1]***

 ***Mr of sodium chloride = 23+35.5 = 58.5 x 2 = 117 [1]***

 ***Ratio of sodium chloride to sodium carbonate 117/106***

 ***Mass of sodium chloride 5.3 x 117/106 = 5.85g [1]***

5. 0.010 moles of C4H10 reacts with oxygen as in the following equation:

C4H10 + O2  \_\_\_CO2 + \_\_\_H20

 1.76g of carbon dioxide and 0.90 of water are produced.

 Use this information to work out the balancing numbers for carbon dioxide and water. (4)

 ***4 CO2 and 5 H2O***

 ***Correct answer with or without working scores 4 marks***

 ***If the answer is incorrect award up to 3 marks for the working***

 ***Mr CO2 = 44 and Mr H2O = 18 (1)***

 ***moles CO2 = 0.040 (1)***

 ***moles H2O = 0.050 (1)***

6. 84 tonnes of nitrogen were mixed with 30 tonnes of hydrogen in the following equation:

N2(g) + 3H2(g)  2NH3(g)

1. Calculate the number of moles of nitrogen and hydrogen and calculate which reactant is the

 limiting factor. (3)

 ***3,000,000 moles of nitrogen (1)***

 ***15,000,000 moles of hydrogen (1)***

 ***(using the 1:3 ratio of N2 (g) + 3 H2 (g)) we need 5,000,000 moles of N2 therefore it is the limiting***

 ***reactant (1)***

1. Calculate the maximum mass of ammonia that can be produced from 42 tonnes of nitrogen. (3)

 ***51 tonnes***

 ***correct answer with or without working scores 3 marks***

 ***if the answer is incorrect award up to 2 marks for the working***

 ***3,000,000 moles of N2 will give 6,000,000 moles of NH3***

 ***Mr NH3 = 17***

**D. Calculations part 2 – Concentrations of solutions**

1. A technician made up a solution of sodium hydroxide by placing 5.00g of solid sodium hydroxide in a flask

 and adding 100cm3 of water. She placed in the stopper and shook until the reaction had stopped. What

 was the concentration of the solution in g/dm3? (1)

 ***50 g/dm3 [1]***

2. A solution of copper chloride has a concentration of 300g/dm3. What is the mass of copper chloride in

 500cm3 of the solution? (2)

 ***500/1000 = 0.5 g/dm3 (1)***

 ***300g/dm3 x 0.5 = 150g (1)***

3. **Higher:**

 Explain how the mass of a solute and the volume of water effect the concentration of a solution. (2)

 ***A greater mass of solute in a certain volume of water → more concentrated solution, [1]***

 ***greater volume of water for a certain mass of solute → less concentrated solution [1]***

**CHEMISTRY ONLY**

**E. Quantities part 1 – Percentage yield and atom economy**

1. Give two possible reasons for the actual yield in a reaction being less that the maximum theoretical

 yield. (2)

***ANY TWO OF:***

***Some of the product may have been lost when it was separated from the reaction mixture,***

***The reactants may have reacted in a different way to the expected reaction,***

***The reaction may be reversible,***

***Not all the reactants reacted.***

2. Magnesium is burnt in air. The theoretical yield of magnesium oxide is 5g, but only 4.5g is produced.

 What is the percentage yield? (1)

***90%***

3. Lead nitrate and potassium iodide solutions are mixed to make solid lead iodide. The solid is then

 separated using the following equipment:



 Suggest why the actual yield is less than the theoretical yield. (1)

***Some of the product might have stuck to the filter paper/may have been lost (1)***

4. **Higher:**

 100g of magnesium carbonate is heated. It decomposes to make magnesium oxide and carbon dioxide.

 Calculate the theoretical yield of magnesium oxide made. (2)

MgCO3  MgO + CO2

 ***Mr of MgCO3 = 24 + 12 + (16x3) = 84***

 ***Mr of MgO = 24 + 16 = 40***

 ***84g of MgCO3 would make 40 g of MgO (1)***

 ***So 200g would make 47.6g (1)***

5. Calculate the atom economy for making hydrogen from the following reaction: (1)

C(s) + 2H2O(g)    →    CO2(g) + 2H2(g)

 ***4/48 x 100 = 8.3%***

6. Suggest why industrial processes need as high an atom economy as possible? (2)

***ANY TWO OF:***

***Reduces the production of unwanted products,***

***Makes the process more sustainable,***

***So that they can sell it to make money.***

**F. Quantities part 2 – Moles of solutions and gases (HT)**

1. What is the concentration of a solution that has 0.25 mol of solute in 135cm3 of solution? (1)

 ***Concentration = number of moles ÷ volume = 0.25 mol ÷ 0.135 dm3 = 1.85 mol/dm3 (1)***

2. How many moles of copper sulfate are there in 40cm3 of a 0.1 mol/dm3 solution? (1)

***Number of moles = 0.1 mol/dm3 × 0.040 dm3 = 0.0040 mol/dm3 (1)***

3. Calculate the concentration in mol/dm3 of a solution that has 2 mol of an alkali in 250 cm3 of solution.(2)

 ***Concentration = number of moles ÷ volume = 2 mol ÷ 0.250 dm3 (1) = 8 mol/dm3 (1)***

4. What mass of sodium fluoride (NaF) is in 250cm3 of a 2 mol/dm3 solution? (2)

 ***Mass of 1 mole of NaF = 23 + 19 = 42 g
 In 1 dm3 of a 2 mol/dm3 solution, there are (42 × 2) = 84 g of NaF (1)***

 ***In 250 cm3, there are 84 g × (250 cm3 ÷ 1000 cm3) = 21 g (1)***

5. It takes 27.00cm3 of hydrochloric acid to neutralise 25.00am3 of sodium hydroxide at a concentration on

 1.0 mol/dm3. Calculate the concentration of hydrochloric acid in g/cm3. (4)

***Number of moles of sodium hydroxide = concentration × volume***

 ***= 1 mol/dm3 × (25 ÷ 1000) dm3 = 0.025 mol (1)
The equation for the reaction shows that 1 mole of sodium hydroxide reacts with 1 mole of***

***hydrochloric acid. So there is 0.025 mol of HCl in 27 cm3 of solution.
So the concentration of HCl in mol/dm3 = number of moles ÷ volume***

 ***= 0.025 mol ÷ (27 ÷ 1000) dm3 = 0.925 mol/dm3 (1)
The mass of 1 mole of HCl is (1 + 35.5) = 36.5 g (1)
So the concentration in g/dm3 = 36.5 g/mol × 0.925 mol/dm3 = 33.8 g/dm3 (1)***

6. Calculate the volume of 0.7 mol of carbon dioxide gas at RTP. (1)

***0.7 x 24 = 16.8 dm3 (1)***

7. What is the volume 12.3g of butane gas (C4H10) at RTP? (3)

 ***Mr = 58 (1)***

 ***Moles = 12.3/58 = 0.21 mol (1)***

 ***Volume = 0.21x24= 5.09 dm3 (1)***